

DEEP SPACE (TREATY) EXPLORATION: REVIVING TODAY'S OBSOLETE SPACE TREATIES

*Matthew B. Hershkowitz**

The Cold War gave rise to more than just turmoil on Earth; it was also the impetus for five space treaties that still govern how countries access and interact in outer space today. Yet, technology has elevated humanity's capabilities far above that which was foreseeable to the treaties' drafters.

First, the growth of privatized space transportation companies, such as SpaceX, has illuminated potential flaws in the treaties with regard to enforcement mechanisms. Further, the advent of colonizing the Moon and Mars and the idea to mine the Moon and asteroids highlights the possibility that the treaties may leave the door open to a tragedy of the commons. Finally, the technological leaps in weaponry made in the last fifty years has made the treaties almost inapplicable to today's weapons, which renders maintaining peace in space for the future questionable.

Consequently, the space treaties are in desperate need of modernization. The parties to the treaties should amend the treaties to include enforcement mechanisms and identify a dispute resolution process. Additionally, the parties should better define ambiguous terms in the treaties that leave space susceptible to a tragedy of the commons. Finally, the parties should amend the treaties to prohibit a wider variety of weapons, including those unanticipated by the drafters.

* J.D., Fordham University School of Law, 2018; B.S. Mechanical Engineering, Lehigh University, 2014. I would like to dedicate this Paper to my grandparents, Joseph and Charlotte Hershkowitz, who have always supported and inspired me. I would also like to thank my family and friends for their continued support.

I. INTRODUCTION	3
II. THE OUTER SPACE TREATY	4
A.Environment Surrounding the Outer Space Treaty’s Creation... 4	
B.The Outer Space Treaty	5
C.The Four Subsequent Treaties	9
III.Current Events and the Treaties’ Inadequacies	11
A.Privatized Space Transportation	12
1. The Expansion of Privatized Space Transportation.....	13
2. The Outer Space Treaty’s Lack of Enforcement	
Mechanisms	16
B. <i>Res Communis</i> Leads to a Tragedy of the Commons:	
Colonization & Mining.....	18
1. Developments in Space Colonization	18
2. Developments in Space Mining.....	20
3. Colonization and Space Mining Results in a Tragedy of	
Commons	21
C.Space War.....	24
IV.MOVING TOWARDS A MODERN OUTER SPACE TREATY	26
A.Transporting the Treaty into the Modern Age.....	26
B.Digging for a Solution to Prevent a Tragedy of Commons	28
C.Disarming Outer Space.....	29
V.CONCLUSION.....	30

I. INTRODUCTION

The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, also known as the Outer Space Treaty, came into force shortly after the Union of Soviet Socialist Republics (“USSR”) rocketed the first man-made satellite into outer space and at a time when few nations could access the depths of space.¹ Shortly following, the international community ratified four additional treaties to elaborate and expand upon the Outer Space Treaty.²

Humankind has made significant innovations in space transportation, colonization, mining, and weaponry in the last five decades,³ which have exposed flaws in the Outer Space Treaty and its progeny.⁴ Specifically, these developments have brought to light concerns that the treaties provide insufficient enforcement mechanisms, fail to protect against a tragedy of the commons, and are becoming obsolete given the latest weaponry.⁵

The states who are parties to the treaties (“state parties” or, individually, “state party”) should address these apprehensions in the following manner. First, state parties should amend the Outer Space Treaty to require state parties to each establish a governmental organization to regulate launching objects into space as well as *all* activities in outer space—*i.e.*, governmental or non-governmental activities in space after a launch—and to identify a dispute resolution process.⁶ Second, the state parties should modify the Outer Space Treaty to clarify the phrase “for the benefit and in the interests of all countries” in Article I.⁷ Such modification must balance the competing interests of promoting space technology and facilities development, against protecting outer space from a tragedy of the commons.⁸ Finally, the state parties should broaden the treaty’s prohibition on weapons in outer space to adequately cover today’s state-of-the-art weaponry and to maintain peace in outer space.⁹

-
1. *See infra* Section I.A.
 2. *See infra* Section I.C.
 3. *See infra* Sections II.A.1, II.B.1–2, II.C.
 4. *See infra* Sections II.A.2, II.B.3, II.C.
 5. *See infra* Part II.
 6. *See infra* Section III.A.
 7. *See infra* Section III.B.
 8. *See infra* Section III.B.
 9. *See infra* Section III.C.

In Part I, this Paper discusses the impetus for the Outer Space Treaty's creation and introduces the five outer space treaties. Then, Part II will review recent developments in outer space transportation, colonization, mining, and weaponry, as well as plans for future development in these areas, and analyze potential defects in the treaties resulting from these advancements. Finally, Part III proposes changes state parties should implement to address these trepidations.

II. THE OUTER SPACE TREATY

The Outer Space Treaty was enacted at a time vastly different from today. However, the treaty persists as the primary international law governing outer space today and motivated the creation of four additional treaties. In this Part, this Paper recounts the setting surrounding the Outer Space Treaty's creation, examines the Outer Space Treaty's provisions, and reviews the four subsequent treaties expanding upon the Outer Space Treaty.

A. Environment Surrounding the Outer Space Treaty's Creation

In 1957, the USSR launched a man-made satellite into outer space, proclaiming its galactic dominance¹⁰ and sparking a "space race" between the United States and the USSR with the objective of landing a human on the Moon.¹¹ The USSR launching its Sputnik 1 satellite into outer space significantly affected, and indeed may have been the motivation for, space law. The launch presented Dwight Eisenhower, the then President of the United States, with the opportunity to either object to the USSR flying a satellite over U.S. soil or to tacitly acknowledge the USSR's right to do so because the United States was likewise interested in flying spy satellites

10. MATTHEW J. KLEIMAN, *THE LITTLE BOOK OF SPACE LAW* 1 (Am. Bar Ass'n ed., 2013) (ebook). A quick note on terminology, this Paper uses the term "outer space" to include both outer space, the moon, and celestial bodies. A celestial body is "any natural body outside the Earth's atmosphere" and includes asteroids. Jeffrey Coffey, *Celestial Body*, UNIVERSE TODAY (Dec. 27, 2009), <https://www.universetoday.com/48671/celestial-body/>.

11. Michael J. Listner, *The Ownership and Exploitation of Outer Space: A Look at Foundational Law and Future Legal Challenges to Current Claims*, 1 REGENT J. INT'L L. 75, 75 (2003).

over USSR territory in the future.¹² Ultimately, President Eisenhower elected to turn a blind eye, establishing that the longstanding international aviation custom which gave countries dominion over the air above its territory, does not apply to outer space.¹³ Henceforth, countries were permitted to fly satellites and other spacecraft over foreign countries' territory.¹⁴

Subsequently, in 1966, the Legal Subcommittee of the United Nations Committee for the Peaceful Uses of Outer Space considered creating a treaty to address outer space use and exploration.¹⁵ The General Assembly reached agreement on the Outer Space Treaty, which opened for signatures in January 1967 and entered into force in October 1967.¹⁶ The Outer Space Treaty sought to assuage the political tensions between states participating in space travel, especially the friction resulting from the space race between the United States and the USSR.¹⁷

B. The Outer Space Treaty

The Outer Space Treaty is comprised of seventeen articles outlining both the international law and the mechanics of the treaty.¹⁸ Article I expresses the idea of *res communis*¹⁹ within outer space, meaning that humanity as a whole, not a single person or sovereignty, owns outer

12. KLEIMAN, *supra* note 10.

13. *Id.*

14. *Id.*

15. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, UNITED NATIONS OFF. FOR OUTER SPACE AFF., <http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html> (last visited Apr. 13, 2018).

16. *Id.*

17. Nikhil D. Cooper, *Circumventing Non-Appropriation: Law and Development of United States Space Commerce*, 36 HASTINGS CONST. L.Q. 457, 459 (2009).

18. See generally Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

19. *res communis*, OXFORD LIVING DICTIONARY, https://en.oxforddictionaries.com/definition/res_communis (last visited Apr. 13, 2018) (defining *res communis* as “[c]ommon property; that which cannot be owned or appropriated.”).

space.²⁰ It provides that “exploration and use of outer space . . . shall be carried out for the benefit and in the interest of all countries . . . and shall be the province of all mankind.”²¹ Article II further supports the *res communis* idea, stating that outer space “is not subject to national appropriation by claim of a sovereignty, by means of use or occupation, or by any other means.”²²

Next, Article III extends international law to outer space, providing that “the exploration and use of outer space” should be carried out in accordance with international law “in the interest of maintaining international peace and security and promoting international co-operation and understanding.”²³ Similarly, Article IV focuses on retaining peace between nations and excluding war and weaponry from outer space. According to Article IV, state parties “undertake not to place in orbit or around the Earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner.”²⁴ Moreover, state parties agree to use the Moon and other celestial bodies “exclusively for peaceful purposes.”²⁵

In addition, Article V concentrates on comradery between state parties in the form of cooperation and assistance between astronauts. Article V requires states to render other state parties’ astronauts assistance in emergencies, to return astronauts to the “[s]tate of registry of their space vehicle” upon an emergency landing, to “render all possible assistance to the astronaut of other [party] [s]tates,” and to alert other state parties as to any phenomena they discover in outer space that “could constitute a danger to the life or health of astronauts.”²⁶ Essentially, astronauts and state parties must assist other astronauts, likely because of the limited assistance even remotely available to astronauts in outer space.

Articles VI through VIII create responsibility for state parties in relation to objects and personnel they launch into outer space.²⁷ Article VI

20. See Cooper, *supra* note 17, at 460.

21. Outer Space Treaty, *supra* note 18, art. I.

22. *Id.* art. II.

23. *Id.* art. III.

24. *Id.* art. IV.

25. *Id.*

26. *Id.* art. V.

27. See *id.* arts. VI-VIII.

imposes responsibility on the state parties for activities of both governmental and non-governmental entities from their state.²⁸ The state parties must ensure that governmental and non-governmental activities conform to this treaty, that non-governmental activities are required to obtain authorization, and that non-governmental activities in outer space are supervised.²⁹ Article VII continues the idea of state party responsibility in requiring that a state party who “launches or procures the launching of an object into outer space . . . is internationally liable for damage to another [s]tate [p]arty to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air or in outer space.”³⁰ Finally, Article VIII provides state parties with jurisdiction and control over the objects that have been launched into outer space and the personnel on those objects while those objects and personnel are in outer space.³¹ Additionally, Article VIII specifies that the state parties retain ownership of the objects regardless of the object’s presence in outer space or on Earth.³²

Article IX returns to the idea of *res communis* in that the state parties must respect other state parties’ interests in outer space. Specifically, Article IX explains that state parties “shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space . . . with due regard to the corresponding interests of all other [s]tate [p]arties to the Treaty.”³³ Further, Article IX states that:

State [p]arties to the Treaty shall pursue studies of outer space . . . and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.³⁴

28. *See id.* art. VI.

29. *Id.*

30. *Id.* art. VII.

31. *See id.* art. VIII.

32. *See id.*

33. *Id.* art. IX.

34. *Id.*

If a state party to the Treaty believes its activities or its nationals' activities will interfere with another state party's activities, it shall undertake to receive prior approval before executing its activities.³⁵

Articles X through XII outline the requirements to permit other state parties to observe a state party's flight;³⁶ notify the United Nations of activities;³⁷ and allow other state parties to use space vehicles, stations, installations, and equipment on a reciprocal basis with sufficient notice.³⁸ Article XIII specifies that joint activities between multiple state parties still must abide by the treaty.³⁹ Finally, Articles XIV through XVII outline the mechanics of the treaty, including signing and amending it.⁴⁰

Nearly one hundred countries have ratified or accessioned to the Outer Space Treaty.⁴¹ It was originally signed by the United States, the USSR, and the United Kingdom on January 27, 1967, and then ratified by those states.⁴² The treaty ultimately went into force on October 10, 1967.⁴³ To date, ninety-one⁴⁴ of the one hundred and ninety-five countries⁴⁵ on Earth have agreed to be bound by this treaty. Notably, the United States, United Kingdom, USSR—which is modern-day Russia⁴⁶—, and the People's Republic of China are all bound by this treaty.⁴⁷ However, many other countries are not parties to the outer space treaty, including North Korea.⁴⁸

35. *Id.*

36. *Id.* art. X.

37. *Id.* art. XI.

38. *Id.* art. XII.

39. *Id.* art. XIII.

40. *See id.* arts. XIV–XVII.

41. *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, U.S. DEP'T OF STATE, <https://www.state.gov/t/isn/5181.htm> (last visited Apr. 14, 2018) [hereinafter *Treaty on Principles*, DEP'T OF STATE].

42. *See id.*

43. *See id.*

44. *See id.*

45. *See Countries in the World*, WORLDOMETERS, <http://www.worldometers.info/geography/how-many-countries-are-there-in-the-world/> (last visited Apr. 14, 2018).

46. *Soviet Union Timeline*, BBC (Oct. 13, 2013), <http://www.bbc.com/news/world-europe-17858981> (providing that Congress of People's Deputies votes for dissolution of the USSR in September 1991 and the Russian government took over office of USSR on December 26, 1991).

47. *Treaty on Principles*, DEP'T OF STATE, *supra* note 41.

48. *See id.*

C. The Four Subsequent Treaties

The Outer Space Treaty subsequently inspired four additional treaties: The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space; the Convention on International Liability for Damage Caused by Space Objects; the Convention on the Registration of Objects Launched into Outer Space; and the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies.

The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (the “Rescue Agreement”) was ratified in 1967 and went into force in 1968.⁴⁹ Briefly stated, the Rescue Agreement provides that “States shall take all possible steps to rescue and assist astronauts in distress and promptly return them to the launching State, and that States shall, upon request, provide assistance to launching States in recovering space objects that return to Earth outside the territory of the launching State.”⁵⁰ In essence, this treaty expands in part upon Article V of the Outer Space Treaty as well as provides greater specificity as to state parties’ responsibilities.⁵¹ For example, if a state party receives information that an astronaut is on the high seas or in any other place not within the jurisdiction of any country, the state party or parties in a position to assist, will assist and return the astronaut to the launching state.⁵²

The Convention on International Liability for Damage Caused by Space Objects (“Liability Convention”) was agreed upon in 1971 and went into force in September 1972.⁵³ The Liability Convention expands on

49. *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space*, UNITED NATIONS OFF. FOR OUTER SPACE AFF.,

<http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introrescueagreement.html> (last visited Apr. 14, 2018).

50. *Id.*

51. Listner, *supra* note 11, at 82–83 (explaining the Rescue Agreement).

52. *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space* art. III-IV, Apr. 22, 1968, 672 U.N.T.S. 119 [hereinafter *Rescue Agreement*].

53. *Convention on International Liability for Damage Caused by Space Objects*, UNITED NATIONS OFF. FOR OUTER SPACE AFF.,

Article VII of the Outer Space Treaty by stating that the launching state party is liable for “damage caused by its space objects” to Earth’s surface and to aircrafts, as well as damage due to its fault in outer space.⁵⁴

The Convention on Registration of Objects Launched into Outer Space (“Registration Convention”) aims to assist state parties in identifying objects in outer space, as is necessary for state parties to execute their responsibilities under the Outer Space Treaty, Rescue Agreement, and Liability Convention.⁵⁵ The Registration Convention “expanded the scope of the United Nations Register of Objects Launched into Outer Space,” which was established in Article VIII of the Outer Space Treaty, and “addressed issues relating to [s]tate [p]arties responsibilities concerning their space objects.”⁵⁶ For example, under the Registration Convention, the launching state must register the space object in the appropriate registry and inform the Secretary-General of the United Nations of the establishment of that registry.⁵⁷

Finally, the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (the “Moon Agreement”) entered into force in 1984.⁵⁸ The Moon Agreement elaborates on the provisions in the Outer Space Treaty regarding the Moon and other celestial bodies.⁵⁹ Specifically, it provides that those bodies should only be used for peaceful purposes, that state parties should not disrupt those bodies’ environments, and that the state parties should inform the United Nations of any station established on those bodies.⁶⁰ It also returns to the idea of *res communis* on the Moon. Essentially, because of the Moon’s common heritage, the

<http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introliability-convention.html> (last visited Apr. 14, 2018).

54. *Id.*

55. *Convention on Registration of Objects Launched into Outer Space*, UNITED NATIONS OFF. FOR OUTER SPACE AFF., <http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introregistration-convention.html> (last visited Apr. 14, 2018).

56. *Id.* See also Listner, *supra* note 11, at 84.

57. *Convention on Registration of Objects Launched into Outer Space* art. II, Nov. 12, 1974, 1023 U.N.T.S. 15 [hereinafter *Registration Convention*].

58. *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies*, UNITED NATIONS OFF. FOR OUTER SPACE AFF., <http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/intromoon-agreement.html> (last visited Apr. 15, 2018).

59. *Id.*

60. *Id.*

Moon Agreement requires the resources contained by the Moon to be governed by international law.⁶¹ Although the United States and Russia have signed onto the previous three additional treaties and the Outer Space Treaty, neither has agreed to be bound by the Moon Agreement.⁶²

III. CURRENT EVENTS AND THE TREATIES' INADEQUACIES

While the Outer Space Treaty and its prodigy address many potential issues arising from outer space travel and recent developments, the treaties were drafted and agreed to in the 1960s, 1970s, and 1980s.⁶³ In 1967, when the Outer Space Treaty came into force, the 25th Amendment to the U.S. Constitution had just been ratified;⁶⁴ the global population was less than half of what it is today;⁶⁵ and the price of a gallon of gasoline was \$0.33.⁶⁶ Even when the most recent treaty, the Moon Agreement, came into force in 1984, the world greatly differed from today: the top song was *Like a Virgin* by Madonna⁶⁷ and DNA profiling was just introduced into criminal

61. *See id.*

62. Listner, *supra* note 11, at 85. *See also* Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1363 U.N.T.S. 3, <https://treaties.un.org/doc/Publication/MTDSG/Volume%20II/Chapter%20XXIV/XXIV-2.en.pdf> [hereinafter Moon Agreement] (listing the states that have signed, ratified or ascended to the treaty, and notably, the United States and Russia are absent from the list).

63. *See supra* Part I.

64. Brian P. Smentkowski, *Twenty-Fifth Amendment*, ENCYCLOPEDIA BRITANNICA, <https://www.britannica.com/topic/Twenty-fifth-Amendment> (last visited Apr. 15, 2018) (providing that the Twenty-fifth Amendment to the U.S. Constitution was ratified on February 10, 1967).

65. 1967 Trivia, *Facts & History*, POP CULTURE TRIVIA, <http://www.pop-culture.us/Annual/1967.html> (last visited Apr. 15, 2018) (providing that the world population was 3,463,000,000 in 1967); *Current World Population*, WORLDOMETERS, <http://www.worldometers.info/world-population/> (last visited Oct. 11, 2019) (constantly updating the population of the world and currently showing over 7.7 billion people).

66. *What Happened in 1967 Important News and Events, Key Technology and Pop Culture*, PEOPLE HISTORY, <http://www.thepeoplehistory.com/1967.html> (last visited Apr. 15, 2018) (providing that the price of a gallon of gasoline in 1967 was thirty-three cents).

67. 1984 Trivia, *Facts & History*, POP CULTURE TRIVIA, <http://pop-culture.us/Annual/1984.html> (last visited Apr. 15, 2018) (providing that the top song in 1984 was *Like a Virgin* by Madonna).

investigation.⁶⁸ More germane here, in 1984, the Hubble Space Telescope had not been launched into orbit yet;⁶⁹ Elon Musk was a thirteen-year-old boy in South Africa;⁷⁰ and even the first piece of the International Space Station (“ISS”) would not be launched for another fourteen years.⁷¹

In this Part, this Paper discusses the recent developments in space and how the Outer Space Treaty and its progeny inadequately address issues recent developments introduce. Specifically, the latest improvements in space transportation, colonization, mining, and weaponry highlight flaws with the treaties’ enforcement mechanisms, illuminate the potential for state parties to exploit outer space—with the result being a tragedy of the commons—and illustrate how the treaty has failed to keep pace with new weaponry.

A. Privatized Space Transportation

Since the ratification of the Outer Space Treaty and its progeny, private companies have begun providing transportation services for both persons and cargo from Earth to the ISS and launching satellites into orbit.⁷² In 2011, the United States retired its space shuttle program,⁷³ leaving the United States totally dependent on the Russian space program to ferry

68. *What Happened in 1984 Important News and Events, Key Technology and Pop Culture*, PEOPLE HISTORY, <http://www.thepeoplehistory.com/1984.html> (last visited Apr. 15, 2018) (providing that DNA profiling developed in 1984).

69. Space News and SPACE.com Staff, *Timeline: 50 years of Spaceflight*, SPACE.COM (Sept. 28, 2012), <https://www.space.com/4422-timeline-50-years-spaceflight.html> (providing that the Hubble Telescope was not launched into orbit on April 25, 1990).

70. *Elon Musk Biography*, BIOGRAPHY, <https://www.biography.com/people/elon-musk-20837159> (last updated Aug. 21, 2019) (providing that Elon Musk was born June 28, 1971 in South Africa).

71. Elizabeth Howell, *International Space Station: Facts, History & Tracking*, SPACE.COM (Feb. 8, 2018), <https://www.space.com/16748-international-space-station.html> (providing that the International Space Station was constructed between 1998 and 2011).

72. *See infra* Section II.A.1.

73. *Space Shuttle Era*, NASA, https://www.nasa.gov/mission_pages/shuttle/flyout/index.html (last visited Apr. 15, 2018) (providing the history of the U.S. space shuttle program and stating that it concluded its final landing was on July 21, 2011 after thirty years of service).

astronauts to and from the ISS.⁷⁴ However, when the National Aeronautics and Space Administration (“NASA”) retired the space shuttle program, it planned to ultimately have private companies assume the responsibility of transporting astronauts.⁷⁵

1. *The Expansion of Privatized Space Transportation*

In the seven years since the space shuttle program concluded, several private companies have endeavored to take over those duties. SpaceX,⁷⁶ a company Elon Musk⁷⁷ founded, has begun transporting cargo to the ISS⁷⁸ and plans to ferry astronauts in the near future.⁷⁹ Standing between SpaceX

74. Mike Wall, *Let the Space Shuttle Rest in Peace, Experts Tell Congress*, SPACE.COM (Oct. 13, 2011), <https://www.space.com/13274-space-shuttle-rip-retirement-congress.html> (explaining that without the space shuttle program, the United States is entirely dependent on using Russian Soyuz rockets to ferry American astronauts to and from the ISS).

75. *Id.* (noting that NASA wants private spaceflight companies to take over taxiing astronauts to the ISS).

76. SpaceX, officially named Space Exploration Technologies Corporation, is a privately held company founded in 2002 by Elon Musk. *About SpaceX*, SPACEX, <http://www.spacex.com/about> (last visited Apr. 15, 2018). SpaceX became a household name after it became the first private company to return a spacecraft from low-earth orbit and when it was the first private company to transport cargo to the ISS. *Id.* In 2017, it was the first company or government to successfully reuse an orbital class rocket for another launch. *Id.*

77. Elon Musk is an entrepreneur and businessman who founded X.com in 1999, which later became PayPal and was sold to eBay for \$1.5 billion, SpaceX in 2002, and Tesla Motors in 2003, and later purchased SolarCity in 2016. *See Elon Musk Biography*, *supra* note 70.

78. *NASA Cargo Launches to Space Station Aboard SpaceX Resupply Mission*, NASA (Aug. 14, 2017), <https://www.nasa.gov/press-release/nasa-cargo-launches-to-space-station-aboard-spacex-resupply-mission>. *See also* Mike Wall, *SpaceX Cargo Capsule Arrives at Space Station with Tons of Supplies*, SPACE.COM (Apr. 4, 2018), <https://www.space.com/40193-spacex-dragon-cargo-capsule-arrives-iss.html>. SpaceX was awarded under the Commercial Resupply Services contract missions to transport cargo from Earth to the ISS and in late 2015, was awarded an additional five contract, bringing the total number of missions to SpaceX to twenty. Peter B. de Selding, *SpaceX Wins 5 New Space Station Cargo Missions in NASA Contract Estimated at \$700 Million* (Feb. 24, 2016), <http://spacenews.com/spacex-wins-5-new-space-station-cargo-missions-in-nasa-contract-estimated-at-700-million/>.

79. Kristen Korosec, *Elon Musk Confirms SpaceX is on Track to Send Humans into Space*, FORTUNE (Aug. 3, 2017), <http://fortune.com/2017/08/03/spacex-astronauts/>

and beginning astronaut transportation are two test flights: one un-crewed test flight and one crewed test flight.⁸⁰ Although the un-crewed test flight was completed in March 2019, the crewed test flight has been delayed until late 2019 at the earliest.⁸¹ SpaceX has also announced it will fly two private passengers around the moon and back to Earth.⁸²

Boeing⁸³ also stepped into the outer space transportation arena. Boeing is developing the Crew Space Transportation (CST)-100 Starliner to transport up to seven passengers, “or a mix of crew and cargo, for missions to low-Earth orbit.”⁸⁴ Boeing is scheduled to perform a crewed test flight carrying two NASA astronauts and a Boeing test pilot later in 2019.⁸⁵

While SpaceX and Boeing receive the most media attention, several other companies have likewise entered the market for launching satellites, cargo, and astronauts into outer space.⁸⁶ Further, some companies have

(explaining that Elon Musk tweeted that he is looking forward to sending humans into space in 2018).

80. Jeff Foust, *SpaceX Delays Commercial Crew Test Flights to Latter Half of 2018*, SPACENEWS (Jan. 11, 2018), <http://spacenews.com/spacex-delays-commercial-crew-test-flights-to-latter-half-of-2018/>.

81. *See id.*; Darrell Etherington, *SpaceX and NASA Detail Cause of Dragon Test Failure, Crewed Flight This Year Looks ‘Increasingly Difficult’*, TECHCRUNCH (July 15, 2019), <https://techcrunch.com/2019/07/15/spacex-and-nasa-detail-cause-of-dragon-test-failure-crewed-flight-this-year-looks-increasingly-difficult/>; Ryan Whitwam, *SpaceX Crewed Dragon Test Flight Finishes with Perfect Splashdown*, EXTREME TECH (Mar. 8, 2019), <https://www.extremetech.com/extreme/287299-spacex-crewed-dragon-test-flight-finishes-with-perfect-splashdown>.

82. Calla Cofield, *SpaceX to Fly Passengers on Private Trip Around the Moon in 2018*, SPACE.COM (Feb. 27, 2017), <https://www.space.com/35844-elon-musk-spacex-announcement-today.html> (explaining that two private individuals have approached SpaceX and paid a hefty deposit to fly a loop around the Moon).

83. “Boeing is the world’s largest aerospace company” headquartered in Chicago, Illinois. *Boeing in Brief*, BOEING, <http://www.boeing.com/company/general-info/> (last visited Apr. 15, 2018).

84. *CST-100 Starliner*, BOEING, <http://www.boeing.com/space/starliner/> (last visited Apr. 15, 2018) (describing Boeing’s passenger-transporting space capsule).

85. Jeff Foust, *Boeing Delays Starliner Test Flights*, SPACENEWS (Apr. 3, 2019), <https://spacenews.com/boeing-delays-starliner-test-flights/>.

86. Blue Origin, a company founded by Jeff Bezos, focuses on transporting anything, whether it be persons or cargo, into space using reusable rockets. Charles Fishman, *Is Jeff Bezos’ Blue Origin the Future of Space Exploration*, SMITHSONIAN MAGAZINE (Dec. 2016), <https://www.smithsonianmag.com/innovation/rocketeer-jeff-bezos-winner-smithsonians-technology-ingenuity-award-180961119/>. Blue Origin seeks to launch tourists, astronauts, cargo, and satellites into space. *Id.* Jeff Bezos is the founder

primarily focused on sending private passengers into outer space. Virgin Galactic, a company Sir Richard Branson's⁸⁷ Virgin Group founded, has set its sights on "becoming a world leader in small satellite launches and sub-orbital commercial space tourism with a longer term vision to develop other space technologies that have the potential to open space to significantly more people and users."⁸⁸ In 2018, Virgin Galactic conducted its first supersonic, rocket-powered flight, inching it one step closer to commercial space tourism flights.⁸⁹ The company intends to charge customers \$250,000 per seat to fly them into space to view the Earth and experience several minutes of weightlessness.⁹⁰

and CEO of Amazon, an online marketplace, with a net worth of \$114 billion. *Jeff Bezos*, FORBES, <https://www.forbes.com/profile/jeff-bezos/> (last updated Sept. 9, 2019). Another player in the outer space cargo transportation market is Northrop Grumman, a global security company that provides cargo delivery services to the ISS. *Northrop Grumman's Cygnus Spacecraft Departs International Space Station, Begins Secondary Mission*, NORTHROP GRUMMAN, <https://northropgrumman.gcs-web.com/news-releases/news-release-details/northrop-grumman-acquire-orbital-atk-92-billion> (last visited Sept. 24, 2019). In addition to its own operations, Boeing is also involved in a joint venture with Lockheed Martin called United Launch Alliance (ULA). *United Launch Alliance*, BOEING, <https://www.boeing.com/space/united-launch-alliance/> (last visited Apr. 15, 2018). ULA has launched more than 100 satellites into outer space orbit. *Id.*

Stratolaunch, a company founded by former Microsoft co-founder Paul Allen, aims to make launching into low-Earth orbit more affordable and thus create "more opportunities for commercial, philanthropic and governmental organizations to collect rich and actionable data and drive advancements in science, research and technology from space." Colleen Leahy, *Apollo Engineer: Space Exploration is Worth the Cost*, WIS. PUB. RADIO (June 1, 2017, 4:15 PM), <https://www.wpr.org/apollo-engineer-space-exploration-worth-cost>; Paul Allen, FORBES, <https://www.forbes.com/profile/paul-allen/> (last visited Apr. 15, 2018) (providing Paul Allen's notable biographical points).

87. Sir Richard Branson is an entrepreneur and founder of the Virgin Group, a multinational corporation that includes Virgin Atlantic, Virgin Mobile, Virgin Records, and, most importantly here, Virgin Galactic. See *Richard Branson Biography*, BIOGRAPHY, <https://www.biography.com/people/richard-branson-9224520> (last updated June 25, 2019) (providing Sir Richard Branson's biography); *Virgin Branded Companies*, VIRGIN, <https://www.virgin.com/virgingroup/company/branded> (last visited Apr. 15, 2018) (listing all the Virgin-branded companies).

88. *Virgin Galactic*, VIRGIN, <https://www.virgin.com/virgingroup/company/virgin-galactic> (last visited Apr. 15, 2018).

89. Fiona Hartley, *Footage Shows Virgin Galactic's SpaceShipTwo Take First Successful Test Flight*, DEZEEN (Apr. 13, 2018), <https://www.dezeen.com/2018/04/13/one-minute-movie-virgin-galactic-spaceshiptwo/>.

90. *Id.*

2. *The Outer Space Treaty's Lack of Enforcement Mechanisms*

When the Outer Space Treaty was enacted, only a few countries on Earth had the capability to launch a person, cargo, or satellite into outer space—the United States and USSR.⁹¹ On the other hand, today, not only are many countries capable of doing so, but so are private companies within those countries.⁹² Consequently, these changes have illuminated weaknesses in the Outer Space Treaty and its progeny, namely issues with enforcement.

First, while Article VI of the Outer Space Treaty imposes liability on state parties for the actions of nationals—i.e., companies or persons from that country—it does not require the country to establish an enforcement mechanism within the state.⁹³ For example, the U.S. Federal Aviation Administration's Office of Commercial Space Transportation regulates “commercial launch or reentry activities,” but does not regulate the movements of spacecraft once they are in orbit.⁹⁴ Consequently, the U.S. government lacks a designated avenue to regulate spacecraft while it is in orbit, as opposed to during launch or reentry. While the international community could still hold the United States accountable for its nationals' activities,⁹⁵ the government would have to use another path to reprimand its nationals. Further, the Outer Space Treaty imposes a duty on the state party to assure that nationals' activities are carried out in accordance with the treaty,⁹⁶ which is difficult in light of the U.S. government's lack of a regulating organization overseeing orbiting spacecraft.

91. See *supra* Section I.A.

92. See *The 10 Countries Most Active in Space*, AEROSPACE TECH. (Dec. 21, 2015), <https://www.aerospace-technology.com/features/featurethe-10-countries-most-active-in-space-4744018/>; see *supra* Part I.

93. See Outer Space Treaty, *supra* note 18, art. VI.

94. Office of Commercial Space Transportation, FED. AVIATION ADMIN., https://www.faa.gov/about/office_org/headquarters_offices/ast/ (last modified Aug. 26, 2019, 10:55 AM).

95. See Outer Space Treaty, *supra* note 18, art. VI (stating that “[s]tate [p]arties to the Treaty shall bear international responsibility for national activities in outer space, including the Moon and other celestial bodies, whether such activities are carried on by governmental agencies or non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty).

96. *Id.*

Second, the Outer Space Treaty, Rescue Agreement, and Registration Convention do not specify a means to resolve disputes pursuant to the treaties.⁹⁷ Further, they do not specify which court has jurisdiction over resolving any conflicts brought pursuant to the treaties, leaving several unanswered questions. For example, if a state party wants to enjoin another state party from launching a satellite because the state party believes the satellite contains a nuclear weapon,⁹⁸ which court can the state party turn to resolve the conflict?

The United Nations facilitated the creation of the Outer Space Treaty⁹⁹ and its Office for Outer Space Affairs manages the United Nations responsibilities regarding the Outer Space Treaty and its progeny.¹⁰⁰ Yet, the Outer Space Treaty does not specify a United Nations court in which to resolve any dispute arising from the treaties.¹⁰¹

On the other hand, the Liability Convention and the Moon Agreement specify that state parties can negotiate through diplomatic relations or, if the parties are members of the United Nations, bring it to the Secretary-General of the United Nations.¹⁰² Therefore, if a party claims damages under the Liability Convention or if the dispute is pursuant to the Moon Agreement, the parties can bring the dispute before the United Nations,

97. See Outer Space Treaty, *supra* note 18, art. VI (providing that “[s]tate [p]arties to the Treaty bear international responsibility” but not specifying an authority under which that responsibility should be enforced); Rescue Agreement, *supra* note 52; Registration Convention, *supra* note 57.

98. The state party would have ground to enjoin the launching state under Article IV of the Outer Space Treaty. See Outer Space Treaty, *supra* note 18, art. IV.

99. See *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, *supra* note 15.

100. *Roles and Responsibilities*, UNITED NATIONS OFF. FOR OUTER SPACE AFF., <http://www.unoosa.org/oosa/en/aboutus/roles-responsibilities.html> (last visited Apr. 15, 2018).

101. See generally Outer Space Treaty, *supra* note 18 (providing that any “practical questions” regarding state parties’ exploration and use of outer space will be resolved by the “appropriate international organization or with one or more States members of that international organization” but does not designate an organization or which judicial body within the organization is responsible.).

102. See Convention on International Liability for Damage Caused by Space Objects art. IX, Nov. 29, 1971, 961 U.N.T.S. 187 [hereinafter *Liability Convention*]; Moon Agreement, *supra* note 62, art. 15.

although the convention does not specify a court.¹⁰³ While claims under the Liability Convention and the Moon Agreement have the Secretary-General of the United Nations as an authority to assist in resolving a dispute,¹⁰⁴ the authority that should resolve claims pursuant to the Outer Space treaty, Rescue Agreement, and Registration Convention is unclear.

B. *Res Communis* Leads to a Tragedy of the Commons:
Colonization & Mining

With the increased interest in space colonization and mining, the idea that all of outer space should be shared between all of humanity encounters complications. Namely, if everyone jointly shares but no party *owns* a piece of outer space, who will protect it if a state or private company seeks to exploit it, especially in light of the vagueness in the Outer Space Treaty's phrasing.

1. *Developments in Space Colonization*

Elon Musk intends to make humans a multi-planetary species.¹⁰⁵ SpaceX's vision "centers on a reusable rocket-and-spaceship combo," which Musk has named the "Interplanetary Transport System" ("ITS").¹⁰⁶ Musk plans to use a reusable rocket to launch passenger spaceships and fuel tankers into orbit around Earth and then land the rocket back on Earth.¹⁰⁷ The fuel tankers will provide fuel to the spaceships and each will remain in orbit until it is empty and then return to Earth to be refilled and relaunched into orbit.¹⁰⁸ The spaceships will journey to and from Earth's orbit to Mars when the planets align favorably.¹⁰⁹ To fuel the spaceships

103. See Liability Convention, *supra* note 102, art. IX; Moon Agreement, *supra* note 62, art. 15.

104. See Liability Convention, *supra* note 102, art. IX.

105. Mike Wall, *SpaceX's Mars Colony Plan: How Elon Musk Plans to Build a Million-Person Martian City*, SPACE.COM (June 14, 2017), <https://www.space.com/37200-read-elon-musk-spacex-mars-colony-plan.html>. Elon Musk recently published his, and SpaceX's, plan to colonize Mars. See generally Elon Musk, *Making Humans a Multi-Planetary Species*, 5 NEW SPACE 46 (2017).

106. Wall, *supra* note 105.

107. See *id.*

108. See *id.*

109. *Id.*

for the journey from Mars, Musk plans to construct a facility on Mars capable of producing a “methane-based propellant.”¹¹⁰ He also predicts that with this reusable system, the cost of transporting a person to Mars will be reduced from an estimated \$10 billion to merely \$200,000.¹¹¹ He further forecasts that the system could begin transporting humans to Mars in about ten years, and that in the next fifty to one hundred years, his system could transport one million people.¹¹²

The President of the United States, Donald Trump, likewise weighed in on humanity’s future on Mars. In a directive, President Trump amended the National Space Policy to restate its purpose as to:

Lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities. Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations.¹¹³

In other words, the United States seeks to establish colonies on Mars and the Moon, and potentially mine the Moon for resources.

Moon colonization may not be as far off as some may think. A group of space experts, including lead NASA scientists, predicted in 2016 that humans could colonize the Moon by 2022.¹¹⁴ Such a moon base could house ten people for up to a year, and could eventually facilitate up to one hundred people.¹¹⁵ According to one NASA technologist, robots will need to construct the base and then humans can visit.¹¹⁶ Many scientists see

110. *Id.*

111. *Id.*

112. *Id.*

113. Space Policy Directive No. 1, 82 Fed. Reg. 59,501 (Dec. 11, 2017).

114. Fiona MacDonald, *NASA Scientists Say We Could Colonise the Moon by 2022...For Just \$10 Billion*, SCIENCE ALERT (Mar. 22, 2016), <https://www.sciencealert.com/nasa-scientists-say-we-could-colonise-the-moon-by-2022-for-just-10-billion>.

115. *Id.*

116. Sydney Pereira, *Life on the Moon: NASA Technologist Describes Our Future Lunar Colony*, NEWSWEEK MAG. (Dec. 16, 2017), <http://www.newsweek.com/2018/01/05/life-moon-nasa-technologist-describes-our-future-lunar-colony-750286.html>. For an extensive discussion of how a lunar base would

establishing a colony on the Moon as a stepping stone to colonizing Mars.¹¹⁷

Even outer space, as opposed to the planets or the Moon, has been targeted for colonization. Orion Span, a start-up company located in Silicon Valley, has announced plans to construct an orbiting hotel beginning in 2019 and launch it into orbit in 2021.¹¹⁸ The hotel will be able to accommodate four visitors at a time and the guests will enjoy the views for twelve days at a hefty \$9.5 million per person price tag.¹¹⁹

2. *Developments in Space Mining*

In light of the limited resources on Earth, humans have also begun pursuing mining the Moon and asteroids for resources.¹²⁰ For example, in 2015, China's launched a lunar probe to collect samples containing helium-3 from the Moon.¹²¹ Helium-3 is a particularly good fuel for nuclear fusion energy generation¹²² but is rare on Earth because Earth's magnetic field repels most of the helium-3 the sun emits.¹²³ The Moon

be constructed, what it would look like, how it would function, and how humans would survive living there, see generally *id.*

117. See MacDonald, *supra* note 114.

118. Denise Chow, *This Luxury Space Hotel Could be Up and Running in Four Years*, NBC NEWS (Apr. 6, 2018), <https://www.nbcnews.com/mach/science/luxury-space-hotel-could-be-running-four-years-ncna863366>.

119. *Id.*

120. See generally Dylan Love, *The Next Frontier: Space Miners Are the Universe's Future Tycoons*, NBC NEWS, <https://www.nbcnews.com/mach/space/next-frontier-space-miners-are-universe-s-future-tycoons-n698711> (last updated Dec. 26, 2016, 12:57 PM) (discussing asteroid mining); Mike Wall, *Asteroid Mining May Be a Reality by 2025*, SPACE.COM (Aug. 11, 2015), <https://www.space.com/30213-asteroid-mining-planetary-resources-2025.html> (explaining same); John Hewitt, *China Is Going to Mine the Moon for Helium-3 Fusion Fuel*, EXTREME TECH (Jan. 26, 2015, 1:01 PM), <https://www.extremetech.com/extreme/197784-china-is-going-to-mine-the-moon-for-helium-3-fusion-fuel> (discussing mining the Moon for helium-3 fusion fuel).

121. See Hewitt, *supra* note 120.

122. For an explanation of helium as part of the nuclear fusion energy generation, see generally *Nuclear Fusion Power*, WORLD NUCLEAR ASS'N, <http://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-fusion-power.aspx> (last updated Nov. 2017).

123. See Hewitt, *supra* note 120.

could also provide other raw materials for use on Earth, including iron ore and titanium.¹²⁴

Other companies target asteroids. Planetary Resources, a private company, “aims to be the leading provider of resources for people and products in space through its goal of identifying, extracting, and refining resources from near-Earth asteroids.”¹²⁵ The company has recently launched its second satellite to “detect water resources in space and has completed the world’s first deep space resource exploration plan to characterize hydrated resources on near-Earth asteroids.”¹²⁶ Another company, Asterank, has gone as far as to estimate the profit that would result from mining over 600,000 asteroids.¹²⁷ According to Asterank, a single asteroid could create billions of dollars in profit to its miner.¹²⁸

Mining asteroids may be an opportunity to expand the quantity of resources available for human use. It could also assist in making humans a multi-planetary species because, if fuel sources on asteroids exist, spaceships could refuel while transporting people or cargo between planets, causing the fuel tankers Elon Musk proposes¹²⁹ to possibly become unnecessary.¹³⁰ Primarily, miners seek water or ice because it can be broken down into hydrogen and oxygen, which are the bases for rocket fuel.¹³¹

3. *Colonization and Space Mining Results in a Tragedy of Commons*

Colonizing the Moon and Mars, and mining the Moon and asteroids illuminates a potential weakness in the Outer Space Treaty. The Outer Space Treaty specifies that “[o]uter space, including the [M]oon and other

124. *Id.*

125. *Timeline*, PLANETARY RESOURCES, <https://www.planetaryresources.com/company/timeline/> (last visited Apr. 21, 2018).

126. *Id.*

127. *See* ASTERANK, <http://www.asterank.com/> (last visited Apr. 21, 2018) (providing detailed statistics of the mass, composition, cost, and profit of over 600,000 asteroids.)

128. *See id.*

129. *See supra* note 105.

130. *See* Love, *supra* note 120 (explaining that space mining is a “killer technology for interstellar travel and exploration”).

131. *Id.*

celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means.”¹³² The Outer Space Treaty also provides that “[t]he exploration and use of outer space, including the [M]oon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries.”¹³³ These provisions protect against state claims of ownership over outer space and partially against states exploiting outer space, but also introduce potential issues.

The non-appropriation clause is great in theory but may encounter difficulties in application. The purpose is clear throughout the Outer Space Treaty that outer space is to be shared by all states to the exclusion of none so that all states can harmoniously co-exist.¹³⁴ However, non-appropriation may lead to a lack of accountability. When there were only a few states parties in space, non-appropriation may have made sense because it was easy to hold only a few state parties accountable for their actions, but with the explosive growth in recent years, the number of state parties using and exploring space has skyrocketed.¹³⁵ It would not be easy today, and even more difficult in the future, to hold each of the many entities in space accountable for their actions. Essentially, non-appropriation opens the door for a tragedy of the commons where because the shared public resource—outer space—is subject to use by self-interested individual parties without limit, those individuals exploit the shared resource without consequence.¹³⁶ As a result, outer space is eventually depleted.

One may point to the other provision outlined above—that the use or exploitation of outer space must be for the benefit and in the interest of all

132. Outer Space Treaty, *supra* note 18, art. II.

133. *Id.* art. I.

134. See generally Outer Space Treaty, *supra* note 18.

135. See *supra* Part II.

136. A tragedy of the commons occurs when a shared resource, such as outer space as a result of the Outer Space Treaty, is shared in the sense that each individual does not have a claim of ownership over any part of the resource, but, rather, has the right to use an undefined portion to his or her benefit. The tragedy occurs when, in absence of regulation, the individuals develop a tendency to exploit the shared resource to their own benefit at the disadvantage to every other party, typically without limit. Eventually, the shared resource is depleted and ruined. See Victor M. Ponce, *Hardin's "Tragedy of the Commons" Revisited Or We Are All in the Same Boat*, SAN DIEGO STATE U., <http://tragedy.sdsu.edu/> (last visited Apr. 22, 2018).

countries—as a tool to regulate states’ exploitation of outer space. However, the provision lacks a clear definition, which further opens the door for the tragedy of commons. For example, China’s mining of the Moon for helium-3 for use in nuclear fusion energy generation could be said to benefit all countries because 1) it’s proving the feasibility of mining the Moon, which other countries may use as inspiration for their own Moon-mining programs, and 2) the nuclear fusion generation process produces no pollution,¹³⁷ which means with a full-scale helium-3 mining operation for use in Chinese nuclear fusion energy generation processes, the world will be less polluted.

Another example is the development of a Moon colony. The Moon is of finite size,¹³⁸ and a state could theoretically build large developments to house its citizens or serve as vacation resorts. What is stopping the state from exploiting the Moon’s surface for its own gain? Many countries could develop Moon colonies, resulting in a race amongst those countries to develop and construct the largest Moon base.¹³⁹ Those countries could then claim that because their Moon colonies are open to all countries, it is in the best interest of all countries that they expand the colonies’ size as much as possible. Eventually, the Moon will be fully developed and inundated with humans, at least reducing the Moon’s beauty and at worst, draining the Moon of its resources.

In essence, the issue is that it is not clear what “for the benefit and in the interests of all countries”¹⁴⁰ means and how direct the benefit to all countries must be. When the treaty took effect, few countries could access

137. See Wendy Koch, *Quest for Pollutant-Free Fusion Energy Takes Major Step*, USA TODAY (Feb. 12, 2014, 1:34 PM), <https://www.usatoday.com/story/news/nation/2014/02/12/fusion-energy-gets-boost/5417503/> (providing that nuclear fusion is a pollutant-free process).

138. See Tim Sharp, *How Big Is the Moon?*, SPACE.COM (Oct. 27, 2017), <https://www.space.com/18135-how-big-is-the-moon.html> (providing that the Moon’s surface is about 14.6 million square miles).

139. See, e.g., Corey S. Powell, *NASA Has Big Plans For the Moon – And Big Competition*, NBC NEWS (Oct. 9, 2017, 9:49 AM), <https://www.nbcnews.com/mach/science/nasa-has-big-plans-moon-it-s-not-only-one-ncna806646> (explaining the United States’s plans for the Moon and how many other countries are competing with the United States to develop Moon mining operations and colonies).

140. Outer Space Treaty, *supra* note 18, art. I.

outer space,¹⁴¹ and the drafter likely did not foresee that tens or even hundreds of states and private companies would eventually explore space with the intent to compete against each other for profit. Therefore, the idea of many individuals exploiting outer space that results in a tragedy of the commons did not even weightlessly drift through their heads.

C. Space War

The idea of space warfare was clearly on the minds of the Outer Space Treaty drafters.¹⁴² However, the drafters could not have imagined the type of weapons or technology countries would develop and how that would affect the treaty's effectiveness. The Outer Space Treaty provides that state parties will not "place in orbit around the [E]arth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction, install such weapons on celestial bodies, or station such weapons in outer space in any other manner."¹⁴³ Further, the Moon must only be used for peaceful purposes.¹⁴⁴

Nuclear weapons are "an explosive device whose destruction potential derives from the release of energy that accompanies the splitting of or combining of atomic nuclei."¹⁴⁵ Meanwhile, weapons of mass destruction ("WMDs"), per the United Nations Office of Disarmament Affairs, "constitute a class of weaponry with the potential to, in a single moment, kill millions of civilians, jeopardize the natural environment, and fundamentally alter the world and the lives of future generations through their catastrophic effects."¹⁴⁶

141. See *supra* Section II.A.2.

142. See Outer Space Treaty, *supra* note 18, art. IV.

143. *Id.*

144. *Id.*

145. Nuclear Weapon, [DICTIONARY.COM](http://www.dictionary.com/browse/nuclear-weapon), <http://www.dictionary.com/browse/nuclear-weapon> (last visited Apr. 22, 2018).

146. Weapons of Mass Destruction, UNITED NATIONS REGIONAL CENTRE FOR PEACE AND DISARMAMENT IN ASIA AND THE PACIFIC, <http://unrcpd.org/wmd/> (last visited Apr. 22, 2018). Another definition provides that weapons of mass destruction are "nuclear, chemical, or biological weapons that can cause indiscriminate death or injury on a large scale." Weapons of Mass Destruction, [DICTIONARY.COM](http://www.dictionary.com/browse/weapons-of-mass-destruction), <http://www.dictionary.com/browse/weapons-of-mass-destruction> (last visited Apr. 22, 2018).

While nuclear weapons and WMDs were the primary concern when the treaty came into force, today, other non-nuclear and non-WMD technology exists that a state may want to station in outer space. For example, the United States recently developed a laser weapon system capable of shooting down unmanned aerial vehicles and attacking objects—such as small boats—on the water’s surface.¹⁴⁷ The U.S. armed forces have developed lasers for mounting on ships, trucks, and even airplanes.¹⁴⁸ Next, the United States aims to develop a laser system mounted on high-altitude drones capable of destroying enemy missiles.¹⁴⁹ It is not far-fetched that the United States or other governments may mount such a laser system on a satellite, or several satellites, orbiting the Earth. While there are technical challenges that governments would need to overcome, it may not be too far off in the future.

If a government were to launch a powerful laser for destroying missiles attached to a satellite into outer space, it would not violate the express terms of the Outer Space Treaty. Under Article IV, nuclear weapons and weapons of mass destruction are not permitted in outer space,¹⁵⁰ but a laser would not fall under either definition. Pinpoint lasers, such as the ones the United States has developed and is currently developing, do not have the capability to kill millions of people in an instant, like bombs or missiles, nor does a laser have to be powered by nuclear power, although that is likely an option.¹⁵¹ Therefore, the treaty, although it may bar most

147. See *Watch the US Navy’s New Laser Weapon in Action*, YOUTUBE (July 17, 2017), https://www.youtube.com/watch?v=tyUh_xSjvXQ.

148. Jeff Hecht, *Lockheed Martin to Develop Laser Weaponry for U.S. Navy Destroyers*, IEEE SPECTRUM (Mar. 2, 2018), <https://spectrum.ieee.org/tech-talk/aerospace/military/lockheed-martin-develops-helios-laser-weapon-for-us-navy>.

149. See Zachary Keck, *The U.S. Military Wants Lasers to Shoot Down North Korean ICBMs*, NAT’L INT. (June 17, 2017), <http://nationalinterest.org/blog/the-buzz/the-us-military-wants-lasers-shoot-down-north-korean-icbms-21197> (explaining that the United States sent out a request for information asking for proposals to develop high altitude unmanned aerial vehicles armed with a laser system to destroy intercontinental ballistic missiles).

150. See Outer Space Treaty, *supra* note 18, art. IV.

151. See, e.g., John Keller, *IntraMicron Eyes High-Power Battery Systems to Support Power-Hungry Shipboard Laser Weapons and Radar*, MIL. & AEROSPACE ELECTRONICS (Apr. 9, 2019), <https://www.militaryaerospace.com/sensors/article/16722077/intramicon-eyes-highpower-battery-systems-to-support-powerhungry-shipboard-laser-weapons-and-radar> (providing an example of a non-nuclear powered laser that could be launched into outer

weapons from space, may not effectively prohibit the weapons of the future.

IV. MOVING TOWARDS A MODERN OUTER SPACE TREATY

The Outer Space Treaty, although groundbreaking and comprehensive when enacted, is no longer as effective today and will be less so in the future. The treaty's drafters could not possibly have envisioned a future where humans would realistically aim to provide privatized space transportation, colonize the Moon and Mars, mine asteroids and the Moon, or develop weapons effective from space that are not nuclear powered or weapons of mass destruction. To continue to be effective, the treaty needs to provide clearer rules as well as expand their breadth to cover unanticipated situations. Therefore, it is time for an update to the Outer Space Treaty and its progeny.

A. Transporting the Treaty into the Modern Age

Privatized space travel has the potential to significantly alter the way humanity interacts with outer space, namely people could travel to outer space for the fun of experiencing weightlessness or to the Moon for vacation. Further, private companies are beginning to transport astronauts and cargo into outer space. Both of these developments have exposed the treaty's lack of enforcement mechanisms. The treaty does not mandate that state parties have an enforcement mechanism and it fails to specify how state parties should resolve disputes. To remedy these shortfalls, the state parties should propose an amendment pursuant to Article XV of the treaty¹⁵² to (1) require each state party to empower an existing state organization or establish a new state organization responsible to regulate the launch of objects into outer space and to regulate the activities of objects while in outer space, and (2) to specify a dispute resolution process for disagreements pursuant to the Outer Space Treaty. The Rescue

space without violating the Outer Space Treaty); Jason Sattler, *High-Energy Laser Systems and the Future of Warfare*, REALCLEAR DEFENSE (Dec. 3, 2018), https://www.realcleardefense.com/articles/2018/12/03/high-energy_laser_systems_and_the_future_of_warfare_113998.html.

152. See generally Outer Space Treaty, *supra* note 18, art. XV (providing process to amend the Outer Space Treaty).

Agreement and Registration Convention should likewise be amended, pursuant to Articles VIII¹⁵³ and IX¹⁵⁴ of those treaties, respectively, to recite a dispute resolution process.

To define a dispute resolution process, the state parties could borrow from the Liability Convention and the Moon Agreement. These treaties essentially provide that the parties should attempt to resolve disputes through diplomatic relations, and if those negotiations fail, the parties may bring the dispute to the United Nations Secretary-General, as long as both parties are members of the United Nations.¹⁵⁵ It may also behoove the parties to include language specifying the court with jurisdiction to resolve disputes—for example, the United Nation’s Court of International Justice—in the amendment.¹⁵⁶

Alternatively, the state parties could agree to resolve disputes through alternative dispute resolution (“ADR”). ADR has been gaining steam in recent years and could be a welcome alternative to litigation.¹⁵⁷ ADR can provide several advantages over litigation, including lower costs, quicker resolutions, and the option to select an expert adjudicator to resolve specialized disputes.¹⁵⁸ Indeed, other international organizations have

153. See generally Rescue Agreement, *supra* note 52, art. 8 (providing process to amend the Rescue Agreement).

154. See generally Registration Convention, *supra* note 57, art. IX (providing process to amend the Registration Convention).

155. See *supra* note 102 and accompanying text.

156. “The [Court of International Justice’s] role is to settle, in accordance with international law, legal disputes submitted to it by states and to give advisory opinions on legal questions referred to it by authorized United Nations organs and specialized agencies.” *The Court*, INT’L CT. JUST., <http://www.icj-cij.org/en/court> (last visited Apr. 22, 2018).

157. See *International Arbitration in a Globalized World*, AMERICAN BAR ASSOCIATION (June 29, 2017), https://www.americanbar.org/groups/dispute_resolution/publications/dispute_resolution_magazine/2014/winter/international-arbitration-in-a-globalized-world/.

158. See *id.*

turned to ADR as another avenue to resolve disputes¹⁵⁹ and organizations have existed since at least 1899 to facilitate ADR.¹⁶⁰

B. Digging for a Solution to Prevent a Tragedy of Commons

Colonization of the Moon and Mars and mining the Moon and asteroids highlight that the *res communis* idea has the idealistic upside of protecting all of humanity's use of outer space by barring appropriation. However, it has the unintended effect of also opening the door for a tragedy of commons.¹⁶¹ Two avenues exist to prevent a tragedy of commons: 1) allow for appropriation of space—as humans did with Earth¹⁶²—or 2) promulgate more finite regulations on an international level that provide a disincentive for states to act in their own self-interest. It seems unlikely that the international community would support permitting appropriation in space because only select countries have the capabilities to fully explore—and therefore possess the ability to claim ownership of—outer space.¹⁶³ Consequently, the likely solution is to provide disincentives to deter the states from exploiting outer space and its resources.

To begin with, the treaty should provide a more specific definition of “for the benefit and in the interests of all countries.”¹⁶⁴ On one hand, the current lack of definition provides an opportunity for state parties to argue

159. See, e.g., *Alternative Dispute Resolution*, WIPO, <https://www.wipo.int/amc/en/> (last visited Aug. 26, 2019); *Efficient Alternative Dispute Resolution in Intellectual Property*, WIPO (June 2009), https://www.wipo.int/wipo_magazine/en/2009/03/article_0008.html. The United Nations also provides ombudsman and mediation services. See *United Nations Ombudsman & Mediation Services*, UNOMS, <https://www.un.org/en/ombudsman/medservices.shtml> (last visited Aug. 26, 2019).

160. See, e.g., *About Us*, PERMANENT CT. OF ARB., <https://pca-cpa.org/en/home/> (last visited Aug. 26, 2019).

161. See *supra* Section II.B.3.

162. See Robert J. Smith, *Resolving the Tragedy of Commons by Creating Private Property Rights in Wildlife*, 1 CATO J. 439, 444, 456–57 (1981) (explaining that a solution humankind has used solve the tragedy of commons is private property rights).

163. See Jonathan O'Callaghan, *How Many Countries Have Rockets Capable of Reaching Space?*, SPACE ANSWERS (Mar. 21, 2013), <https://www.spaceanswers.com/space-exploration/how-many-countries-have-rockets-capable-of-reaching-space/> (“To date there are [nine] countries that have orbital launch capability. These are Russia, the United States, France, Japan, China, India, Israel, Iran and North Korea.”).

164. Outer Space Treaty, *supra* note 18, art. I.

that almost any activity is to humankind's benefit because they are exploring and developing new technology that in the long term will permit humankind to become a multi-planetary species. On the other hand, if the phrase were interpreted literally, a state party would have great difficulty proving that a particular act was "for the benefit and in the interest of all countries."¹⁶⁵ For example, a country mining the moon for helium-3 for its own use is not truly a benefit to *all* humankind because it primarily benefits the mining country and, at best, has a tangential benefit to the rest of Earth.

Another consideration, however, is the effect that the non-appropriation clause and the clause requiring that the use and exploration of outer space must benefit all of humankind has on incentivizing space exploration and use. If it is strictly interpreted as discussed above, then private entities and states will not be incentivized to expend resources to explore and develop technologies to use outer space because those developments could be commandeered by all of humankind. For instance, if a company constructed a mine on a near-Earth asteroid, would that mine have to be open to any state who wants to mine the asteroid? In such case, the incentive for the mining company to invest in transporting materials to the asteroid and constructing a mine is greatly reduced by the fact that another state or company could use its mine at a significantly reduced cost, and therefore much higher profit. Thus, an amendment to the Outer Space Treaty to provide specificity to "for the benefit and in the interests of all countries"¹⁶⁶ will need to balance these competing interests.

C. Disarming Outer Space

The advent of new weaponry has placed the Outer Space Treaty in a difficult position. The laser that the United States developed does not fall into either of the proscribed weapons categories: nuclear weapons or WMDs.¹⁶⁷ Countries are continually developing new weaponry and the Outer Space Treaty needs to keep pace to effectively maintain peace in outer space. To further protect outer space from new developing weapons, the state parties should amend the treaty to broaden the prohibition on weapons. If such an amendment could gain enough support, an

165. *Id.*

166. *Id.*

167. *See supra* Section II.C.

amendment to outlaw all weapons in space may be a progressive step towards protecting peace in outer space.

However, over broadening the prohibition may have unintended negative implications. As discussed, one purpose of the treaties is to benefit all humankind through the use of outer space.¹⁶⁸ Scientific research is one way that humankind may benefit from using outer space.¹⁶⁹ However, scientific equipment may share certain components with weapons. For example, lasers could be weaponized,¹⁷⁰ be used for communicating from space¹⁷¹ or perform scientific research.¹⁷² Too broad of a ban (e.g., a ban on all lasers) could hinder science, but too narrow of a prohibition would allow dangerous weapons to be launched into space.

V. CONCLUSION

The Outer Space Treaty and its progeny require an update. The treaty came into force in an era where few countries could access outer space and when the space transportation, colonization, mining, and weaponry of today and the future, were not foreseeable. In light of these developing areas, the Outer Space Treaty and the subsequent derivative treaties have fallen behind. Space transportation has illuminated the treaties' shortcomings regarding enforcement mechanisms. While the idea of outer space being for all of humankind is enticing, it is unrealistically idealistic under the current treaty because space colonization and mining may result in a tragedy of commons due to a lack of accountability or disincentives. Finally, technology has outpaced many treaties and the Outer Space Treaty

168. See *supra* Section III.B.

169. See, e.g., *What Is the International Space Station*, NASA (Feb. 7, 2018), <https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-the-iss-58.html>; *About the Hubble Space Telescope*, NASA, https://www.nasa.gov/mission_pages/hubble/story/index.html (last visited Aug. 26, 2019).

170. See *supra* Section II.C.

171. See Sophia Chen, *How to Build a Space Communication System Out of Lasers*, WIRED (Feb. 27, 2018), <https://www.wired.com/story/how-to-build-a-space-communication-system-out-of-lasers/>; Patrick Nelson, *NASA to Use Data Lasers to Beam Data From Space to Earth*, NETWORK WORLD (Aug. 30, 2018, 6:02 AM), <https://www.networkworld.com/article/3301294/nasa-to-use-data-lasers-to-beam-data-from-space-to-earth.html>.

172. See, e.g., Meghan Bartels, *NASA Will Launch a Laser Into Space Next Month to Track Earth's Melting Ice*, SPACE.COM (Aug. 23, 2018), <https://www.space.com/41596-nasa-icesat2-earth-ice-satellite-september-launch.html>.

is no exception. The drafters of the Outer Space Treaty could not have foreseen today's innovative weaponry. Consequently, the treaty's proscription of certain weaponry in space may not effectively prohibit tomorrow's, or even today's, weapons. However, the state parties can address these issues through carefully tailored amendments to the Outer Space Treaty and its progeny.